<u>Week #5</u> (Feb. 25 & March 2) Sensory Integration & decision making
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Week #4's topic, adaptation, can be thought of as a set of mechanisms that allows devices with very limited dynamic range (i.e. neurons) to encode salient sensory stimuli over a very large range of environmental conditions. Another strategy to compensate for limited dynamic range, used by virtually all nervous systems, is *parallel processing*. This strategy makes use of complementary pathways that specialize in various regimes. Examples of this are the rod and cone pathways in the retina, the "magno" and "parvo" channels in early vision, and the "what?" vs. "where?" systems of cortical visual areas. The concept of the segregation of different functional attributes gives rise to the obvious question of how information represented in anatomically distinct regions is subsequently integrated to form a seamless representation of the sensory world. This is the famous "binding problem." We will discuss to what extent this is a real problem, followed by several ideas as to how it might be solved.

Whether or not all of an object's attributes are ultimately bound together, there are many instances in which qualitatively different kinds of sensory information are combined to improve perceptual capabilities. In the second half of class, we will discuss two major concepts arising in sensory integration. The first is the issue of *coordinate transforms*. This arises because spatial information obtained from different sense organs is referenced in different ways. For example, visual information is initially in retinotopic coordinates (i.e. features are referenced to the fovea) whereas auditory information is in head-centered coordinates (because the ears are fixed to the head). It is clearly useful to be able to combine both auditory and visual information to locate objects in space, and perceptual experiments show that we indeed make use of both cues. But since the eyes can move with respect to the head, aligning the two sources of information in a common coordinate system is no small feat.

The last major concept we will discuss in class is *how* the different sources of information are combined. Are they simply added together, or are more complicated, nonlinear algorithms involved? And how much emphasis is given to each source? Depending on environmental conditions, one set of inputs may be more reliable than the other. For example, vision is clearly highly reliable for object localization during the daytime, but much less so in the dark. In some cases, it has been shown that human observers combine cues optimally by weighting each source according to its reliability. We will explore the extent to which animals and neurons integrate information in this so-called "Bayes Optimal" way.

Papers for background reading:

Livingstone, M. and Hubel, D. (1988) Segregation of form, color, movement, and depth: anatomy, physiology, and perception. *Science*. **240**:740-9.

On the following Monday we will discuss:

Morgan ML, Deangelis GC, Angelaki DE (2008) Multisensory integration in macaque visual cortex depends on cue reliability. *Neuron*. **59**:662-73.

Your assignment is to write a **<u>commentary</u>**, due, as always, before class on Monday.